The Effect of Gross Domestic Product on Environmental Expenditures

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Abstract

This paper tests the relationship between the dependent variable environmental expenditures and the independent variable GDP. The study includes observations from 180 countries from around the world. Other independent variables that will be used in this study are carbon emissions, urbanization rate, income level of each observation, status as an OECD member, and Environmental Policy Index. The conclusion from my study is that there is a significant positive relationship between Gross Domestic Product and expenditures on environmental protection. Furthermore, there is a positive correlation with the variables on urbanization rate, countries with OECD membership, high-income level countries, and the Environmental Policy Index. There is a negative correlation with the explanatory variables on carbon emissions and middle-income countries.

I. Introduction

The world is in a dilemma of combatting effective environmental sustainability and sustained economic growth. It is believed that efforts toward climate change mitigation are a hinderance to economic growth and sustainability. Among developed and developing countries focused on economic growth, climate change is often an issue that is not taken into consideration regarding economic decision making.

The paper is to understand the relationship between indicators of a country's environmental efforts and consciousness measured in the total amount of environmental expenditures. I want to know how a country's GDP level affects its environmental expenditures.

To elaborate on the dependent variable, environmental protection expenditures is public government funding and disbursement for waste and wastewater management, reduction of pollution, protection of biodiversity and land, and research and development related to environmental protection.

Because global warming is an issue due to high growth in carbon emissions and pollution worldwide, this issue is important. If actions to mitigate climate change are not further pushed globally then there will be uncertainty in the health of the planet and of human life in the years soon to come.

It will help answer the question of if green growth economies are possible. In other words, is having high economic performance possible with efforts to mitigate climate change? Increased research in this field will allow for economic, technological, and environmental innovation such as creating profitable environmental markets and building on existing ones.

The environmental Kuznets curve states that economic development initially leads to deterioration in the environment. However, after a certain level of economic growth, environmental degradation decreases. This suggests an inverted U-shaped relationship between economic performance and environmental degradation. There has been mixed discourse on the effectiveness of this finding.

The hypothesized relationship of the effect of the primary independent variable environmental expenditures and the dependent variable, economic growth, is a positive relationship. The rationale behind this hypothesis is that countries who are willing to spend on the environment as a large share of their GDP tend to be countries who are more well off and advanced in their economies. For each unit of environmental expenditure, the higher the economic growth of a country.

II. Literature Review

Dogan et Lotz (2020) examined the effectiveness of the Environmental Kuznets curve for European countries between the years 1980 -2014. This paper's purpose was to evaluate the role of the economic structure of specific EU countries into testing the Environmental Kuznets Curve (EKC) hypothesis, in the form of the industrial sector's value added. Thus, this study aimed at comparing the results in the empirical relationship among economic development and environmental quality (measured in CO2 emissions) using the "stochastic impacts by regression on population, affluence, and technology", or STRIPAT, model. This study revealed that the EKC hypothesis was not confirmed when industrial share was used as a proxy for economic structure even though the hypothesis was supported when economic growth was employed as an indicator. According to the authors, by replacing the indicator used to describe affluence from GDP to the industrial sector's economic output, the model could not be used for testing robustness. For the EU countries in the study, higher levels of industrialization promoted reductions in the emission levels and did not support the EKC hypothesis. Dogan et Lots (2020) explained that access to modern, cleaner, more efficient technologies would promote environmental healthiness of the overall economy. The authors finally explained that the living standards and purchasing power of the society were important to consider with higher rates of economic growth. As development led to shifting from farming to manufacturing, there would be greater environmental degradation. However, increased productivity and rising real incomes saw a third shift from industrial to the service sector which had lower environmental impact than industrial services.

This literature by Alam et Hasmi (2019) focused on technological innovation in terms of the environment and its effect on GDP. This study examined the carbon emission reduction of OECD countries during the period 1999 to 2014. The STIRPAT model was once again introduced. From which, the authors developed a new model called STIRPART to extend the analysis on the evaluation of factors influencing carbon emissions. In addition, the effects of environmental regulations and environmentally friendly technologies were empirically tested. The authors were examining the impacts that technologies and climate change regulations have on carbon emissions in the context of OECD countries. In the review green technologies were investigated further, and its effects on carbon reduction compared to other technologies. Another interesting aspect of this literature was the examination of environmental policies such as carbon pricing and its effectiveness for carbon reduction. The data utilized 29 out of 35 OECD countries for the given time frame. This was a rather small sample size. From their results the authors indicated that the damaging effects of population and economic activity on carbon emissions far outperformed the positive effects of green innovation and carbon pricing policy instruments on the environment in OECD countries. To conclude, the author suggested further research in subsidizing green technologies in the production and OECD countries setting environmental targets through various methods of climate regulation.

Anglis et al. (2019) analyzed the role of environmental policies and the use of market-based and non-market instruments to challenge the pollution plague and mitigate climate change. The authors incorporated the independent variable ESI- which is the environmental stringency index- and its effect on economic performance. The environmental stringency index is the proxies used to account for environmental regulation. The study tested on a sample of 32 countries observed between 1992-2012. Their contribution to the literature included testing the validity of the Environmental Kuznet Curve by using the stringency of environmental policy measures and its effects in environmental degradation reduction. The authors claimed that economic growth could not be considered as both the cause and the solution to environmental degradation and placed emphasis on the government intervention through environmental policy to abate climate change. The authors described market-based instruments to reduce climate change as environmental tax and tradeable pollution emissions permit system (cap-and-trade system). In the findings there was a cubic relationship between CO_2 per capita and GDP per capita. They conclude that more reliable measures of environmental policy stringency and efficacy are required along with a larger sample.

My contribution to the literature of environmental economics is to increase further research into how certain economic structures may affect environmental efforts. My paper is unique to the topic because it summarizes relationships between environmental expenditures and GDP considering income levels of countries. Also, the countries within my study are diverse in terms of location and status as OECD members. This study does not necessarily focus on specific economic regions such as the EU or physical regions of the world.

III. Data

The *logevenexpend variable* is the natural logarithm of government expenditures on environmental protection. Because the values in the expenditures for environmental protection were large, the natural logarithm is used to linearize the model. This variable allows us to examine the government's allocation of funds in spending towards environmental efforts. The total expenditure on the environment is likely to be influenced by a country's gross domestic product. Most countries in this study have conservative estimates on the number of exports that are allocated for environmental goods with respect to their Gross Domestic Product. The largest value being from China of total expenditures on the environment being a value of $104,305,292,642.05. Although this takes up a small portion of total Gross Domestic Product which is over $14 trillion, it still boasts significance in determining expenditures allocated for the environmental protection. On the opposite spectrum the value with the lowest expenditures on the environmental protection was the Kyrgyz Republic with a value of $320,945.76 and a GDP of just under $8 billion.

The *epi* variable is the Environmental Performance Index. This index rates all countries and was inspired by the ESI- Environmental Stringency Index (Anglis Giacomo Vannoni 2019). The Country with the highest *EPI* is Denmark with a value of 82.5. The country with the smallest in the observation was Myanmar with a value of 25.1 Although going by the index alone is not enough to show current environmental effort, viewing EPI allows a better measure of each individual country's performance. This demonstrates that countries who tend to perform better for the environment will likely spend more on environmental protection measures.

The urbanization rate of a country is the overall percentage of a population that lives in urbanized areas. Urbanization is closely linked to how modernized and industrialized the society is. Highly urbanized cities could influence the economy of the nation. The modernization of these areas could have an influence on how much goes towards environmental protection expenditures as a result. The country with the highest urbanized population was Singapore with 100% of the population being urbanized, while the lowest was Papa New Guinea with 13.2% of the population being urbanized.

OECD member status is a dummy variable, and it provides insight to whether there is a significant effect on environmental expenditures given OECD membership. OECD is the organization of economic and cooperation development. OECD members are countries who have democratic institutions and uphold a free market economy. These countries tend to have highly developed, high-income economies. As a result, membership status has the possibility of influencing countries expenditure for the environmental protection. The use of this variable was inspired by Alam and Hasmi (2019) who observed a sample of 29 OECD Countries within their study. In my study, the total number of OECD member countries comes out to be 33 countries out of 97 observations.

Middle and high are both dummy variables that are used to describe the income level of the countries within the study. The goal of this additional dummy variable was to see if the specific income levels of a nation separated by low, middle, or high income would have any effect on environmental spending of that nation. The use of this variable may give insight to the types of countries that are willing to spend on environmental protection.

The logcarbemission variable is the natural logarithm of global carbon emissions measured in metric kilotons. The decision in using this variable comes from the common measurement of carbon dioxide emission as an indicator of pollution. Economic literature uses this measure to demonstrate the relationship between carbon emissions, which is a greenhouse gas that negatively the environment, and its effect on gross domestic product. Carbon emissions is a common estimator used in literature on the environment seen in the literatures of Hashmi and Alam (2019), Anglis Giacomo Vannon (2019), and Dogan et Lotz (2020). Controlling for carbon emissions would allow us to see how it effects total environmental expenditures.

Table 1. Variable Description

Variable Name	Variable Description	Sample Size	Year	Units	Source
logenvexpend	Natural logarithm of expenditures on environment protection	97	2019	US Dollar	IMF Climate data
Loggdp	Logarithm of the GDP of country	97	2015-2019	US Dollar	World Bank
logcarbemissions	Logarithm of Carbon Emissions	97	2018	Metric Kilotons	World Bank
Urban	Urbanization rate of population in country	97		Percentage	World Bank
Epi	Environmental Performance Index (2020)	97	2020	Index	Yale
Middle	Indicates whether country is either low-income or middle income	97	2018-2020	Low income = 0 Middle income = 1	World Bank
High	Indicates whether country is either low income or high income	97	2020	Low income = 0 High income = 1	World Bank

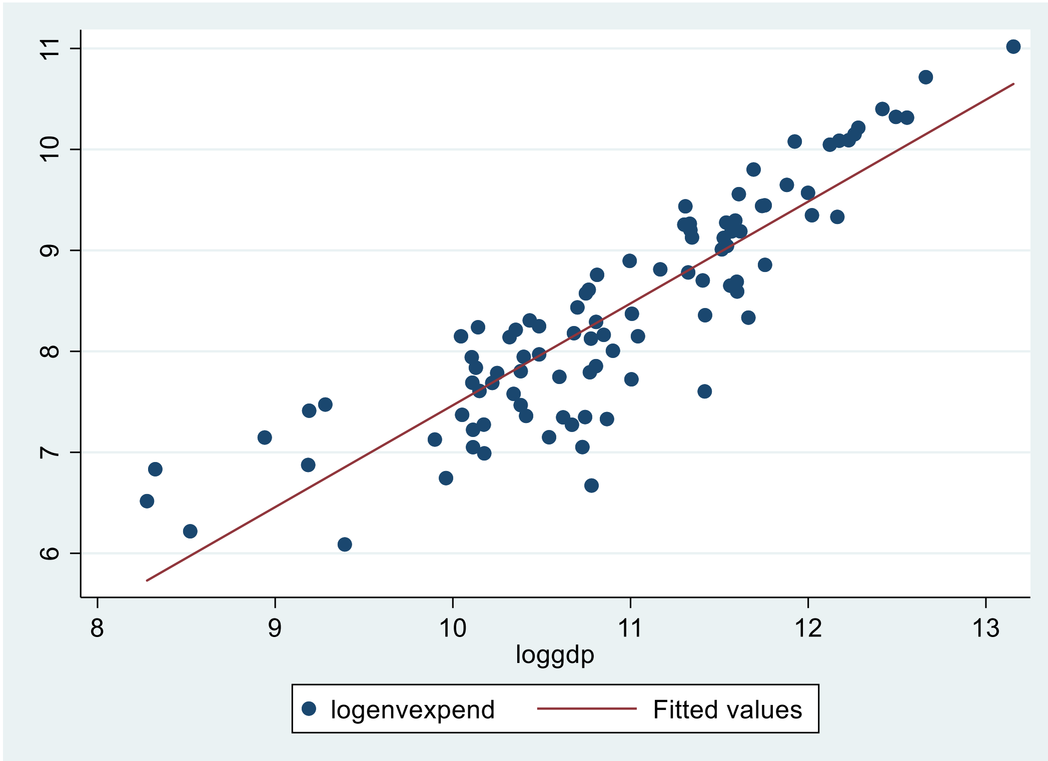
OECD	Indicates whether a country is either an OECD country or not	97	2020	OECD member = 1 Non-member - 0	World Bank

Although intended to be a study from all countries, many countries were omitted due to not having data in certain areas. Also, relevant data sets were examined within the frame of the past 5 years, with the most recent data being displayed now. The observations began at 180 countries but reduced to 97 observations as a result.

Table 2. Descriptive Statistics

Variable Name	Observations	Mean	St. Deviation	Max	Min	Range
logenvexpend	97	8.3	1.14	11.01	5.51	5.5
Loggdp	97	10.91	0.95	13.16	8.28	4.88
logcarbemission	97	4.42	0.92	7.01	1.90	5.11
Epi	97	52.97	16.54	82.5	25.1	57.4
Urban	97	64.76	21.09	100	13.2	86.8
Middle	97	0.54	0.50	1	0	1
High	97	0.40	0.49	1	0	1
OECD	97	0.34	0.48	1	0	1

Figure 1. Government Expenditures v. Annual GDP Growth



CLM/Gauss Markov Assumptions

1. The first assumption states that the model must be linear in parameters. In the graph above, with the natural log of GDP as the independent variable and the log of environmental protection expenditures exhibits a positive linear relation. Also, the model is written as $y = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} + \boldsymbol{\beta_2} \ldots. + \boldsymbol{\beta_k} + \boldsymbol{u}$ Thus, the first assumption is met.

2. The second assumption is random sampling. This condition is met since data was obtained from World Bank and IMF climate data. There was no bias in choosing the countries since values represent the population. However, countries that were omitted were due to not having updated data.

3. The third assumption is no perfect collinearity between parameters. As shown in Table 4 below, this assumption is met. None of the explanatory variables demonstrate a perfect linear relationship. Therefore, this condition is met. However, there is high correlation with a value of 0.94 between a countries GDP and its carbon emissions, this high value will contribute to high multicollinearity in the values.

4. The fourth assumption is the zero conditional mean. Which states that the error term, u, is zero for any given exaplanatory variable. This suggest that this condition is not met. Possible missing or omitted variables could be the effect of a country's poverty rate which may have a negative correlation with the main explanatory variable GDP as well as the dependent variable, environmental protection expenditures. Omission of a poverty rate variable, due to lack of data, could lead to overestimates in our current results.

5. The fifth assumption is homoskedacity, or constant variation in the error for all values of the explanatory variables. To prove homoskedacity, we will view the residual plot of regressing *logenvexpend* on *loggdp*. In the residuals plot in Appendix C, we see that they do range, and do not necessarily have a uniform distribution around the value of 0. We see that values seem to vary more in the negative direction within the middle of the graph. This does not demonstrate a constant variance in environmental expenditure across all levels of GDP. This may suggest that this assumption may not be met and should be taken into consideration when interpreting results.

6. The sixth assumption is that the data is normally distributed. To prove this assumption a normal probability plot was used in Appendix A to analyze both *logenvexpend*. Although there are light tails in the model but not systematic deviations from the normal plot line. From the histograms in Appendix B, the dependent variable shows an even distribution and no heavy skews in the data. There is not too much deviation from the normal line. Thus, this proves that the sample is normally distributed.

III. Results

In Model 1, a simple linear regression demonstrates the linear relationship between environmental expenditures and GDP. The dependent variable is *logenvexpend*, and the independent variable is log*gdp*. Afterwards, there is a more general multiple linear regression adding all the control variables: *logcarbonemiss*, *epi*, and urban. The sample is the same size across all models.

Model 1: ***logenvexpend***= $\boldsymbol{\beta_0 + \beta_{loggdp}}$

Equation 1: ***logenvexpend*** **= -2.62 +**$\mathbf{1.01}_{\boldsymbol{loggdp}}$

From the linear regression, the natural logarithm of gross domestic product of a country has a coefficient of 1.01. This simple linear regression tells us that there is a positive linear relationship between the natural logarithm of expenditure on environmental protection and that of gross domestic product. This means that for every 1 percent increase in the GDP of a country, there is a 1.01 percent increase in the environmental protection expenditures provided by the government. There is 95% confidence that the true value is in the range of 0.90% and 1.12% increase in the expenditures of environmental protection. The R-squared value of this model is 0.78 and the adjusted R-squared value is 0.78. The R-squared values are high, demonstrating a strong correlation between GDP and environmental expenditures. Moreover, the explanatory variable demonstrates to be significant at all levels. The t-statistics is inarguably large, at a value of 15.46 and p-value of approximately 0.

Model 2: $\mathbf{log}\boldsymbol{envexpend} = \boldsymbol{\beta_0} + \boldsymbol{\beta_{loggdp}} + \boldsymbol{\beta}_{\mathbf{logcarbemiss}} + \boldsymbol{\beta}_{\mathbf{epi}} + \boldsymbol{\beta}_{\mathbf{urban}}$

Equation 2: $\boldsymbol{logenvexpend} = -\mathbf{2.26} + \mathbf{0.92}_{\boldsymbol{loggdp}} - \mathbf{0.017}_{\mathbf{logcarbemiss}} + \mathbf{0.014}_{\mathbf{epi}} + \mathbf{0.253}_{\boldsymbol{OECD}} + \mathbf{.0005}_{\mathbf{urban}}$

From the multiple linear regression, this is a more general model. We see that the positive relationship between environmental expenditure and gross domestic products still holds. When the control variables are added in Model 2, we see that the coefficient of log*envexpend* has decreases slightly so that for every 1 percent increase in GDP there is 0.92% increases in environmental expenditures. GDP is still significant at all levels. There is a negative coefficient for carbon emissions. For every 1 percent increase in carbon emissions, there is a .07 % decrease in environmental expenditures. However, this value demonstrates high collinearity with GDP, and it does not show significance at any levels.

The variable *epi* turned out to be significant at all levels of the model. With every 1 unit increase in the environ mental performance index, there is a 1.40 percent increase in environmental expenditures. However, urbanization rate did not turn out to be significant to environmental expenditures. For everyone unit increase in the percent of the urban population, there was a .04% increase in environmental protection spending. The R-squared value of the model increased significantly to 0.84 with an adjusted R-squared value of 0.83.

Table 3. Coefficients

Independent Variables	Model 1	Model 2	Model 3	Model 4
Loggdp	1.01 (0.11)***	0.9166 (.1687) ***	0.8471 (0.0186)***	0.8350 (0.056)***
logcarbemission	-	-0.0721 (.1619)	-	-
Epi	-	0.0176 (0.004)***	0.019 (0.003)***	.013 (0.004)***
OECD	-	-	-	0.2098 (0.1480)
Urban	-	0.0004 (0.0029)	-	
Middle	-	-	-	-0.076 (0.201)
High	-	-	-	.014 (0.592)
intercept	-2.62 (1.25)***	-2.26 (1.095)**	-1.84 (0.536)***	-1.44 (0.592)**
No. of obs.	97	97	97	97
R-squar be	0.7788	0.8387	0.8383	0.2214
Adjusted R-squared	0.7765	0.8317	0.8349	0.1875

*10% ,**5% , ***1% significance levels

Table 4. Collinearity

	logenvexpend	*loggdp*	*logcarbemiss*	*epi*	*OECD*	*urban*	*middle*	*high*
logenvexpend	1							
Loggdp	0.8825	1						
logcarbemiss	0.7959	0.9435	1					
Epi	0.6535	0.5013	0.3624	1				
OECD	0.5863	0.4503	0.2895	0.709183	1			
Urban	0.5068	0.4328	0.3527	0.644076	0.455351	1		
Middle	-0.4728	-0.32442	-0.1491	-0.68312	-0.68464	-0.4410	1	
High	0.4637	0.3194	0.1751	0.6873	0.653791	0.4958	-0.8815	1

IV. Extensions

In Model 3, we see that the control variables *urban* and *logcarbemiss* were omitted from the model. Carbon emissions had a high correlation with the explanatory variable, GDP, with a value as high as 0.9435. Thus, this contributes to multicollinearity within the model. Also, the urban variable did not show any significance and demonstrated moderate collinearity with the environmental performance index. In the model, EPI was kept due to its significance in Model 2. The variable remained significant with the transition to Model 3. The R-squared value was .84, with an adjusted R-squared of 0.83.

Model 3 $\boldsymbol{logenvexpend = \beta_0 + \beta_{loggdp} + \beta_{\mathrm{EPI}}}$

Equation 3: $\boldsymbol{logenvexpend = -1.84 + 0.85_{loggdp} + .019_{\mathrm{EPI}}}$

In the model we see that with a 1% increase in the gross domestic product results in a 0.85 increase in funding for the environment. With environmental performance index, a 1-unit increase in the index value results in a 1.9 % increase in funding towards environmental protection. To test robustness of my refined model, I will perform an F-test, my restricted model was Model 3 and unrestricted model was Model 2.

The null hypothesis is that the coefficients of the natural logarithm of carbon emission and urbanization rate are 0, meaning they are not jointly significant

$H_0 : B_{\mathrm{logcarbemiss}} = 0, B_{\mathrm{Urban}} = 0$

The alternative hypothesis is that the omitted variables are jointly significant.

H_A: Null hypothesis is not true

$$F = \frac{(R_{UR}^2 - R_R^2)/q}{(1 - R_{UR}^2)/df} = \frac{(0.8387 - 0.8383)/2}{(1 - 0.8387)/(97 - 4 - 1)} = 0.114$$

The degrees of freedom for the unrestricted model are 92, with two omitted variables in Model 3 resulting in 2 degrees of freedom for the restricted model. F-statistic = 0.11. The F-critical value at a 5% significance level = 3.10. Because the F-statistic is less than the critical value of F, this indicates that we fail to reject the null hypothesis. Therefore, the variable on carbon emissions and urbanization rate are jointly insignificant in the model.

In the fourth model, the dummy variables are introduced to the previously refined model.

Model 4: $\boldsymbol{logenvexpend = \beta_0 + \beta_{loggdp} + \beta_{\mathrm{logcarbemiss}} + \beta_{\mathrm{epi}} + \beta_{\mathrm{urban}} + \beta_{OECD} + \beta_{\mathrm{middle}} + \beta_{high}}$

Equation 4: $\boldsymbol{logenvexpend = -1.44 - 0.84_{loggdp} + 0.01_{\mathrm{EPI}} + 0.21_{\mathrm{OECD}} - 0.076_{\mathrm{middle}} + 0.014_{\mathrm{high}}}$

From the model, we see that the additional dummy variables did not have significance at any level. The dummy variable that indicated OECD membership for each observation has a positive coefficient value 0.21. The variable on the Environmental Performance Index and GDP maintain significance at all levels. OECD membership increases the environmental funding by 0.21%. The p-value is close to reaching 10% significance at a value of 0.16. The income levels do not show any significance within the model. High income countries have a p-value of and low income countries has a p-value of However, middle income countries result in a 7.6% decrease in the value of environmental protection expenditure, while high income countries result in a 1.4% increase in environmental protection spending. This could be due to middle income countries focusing more on economic growth rather than focusing on the environment as a result.

V. Conclusions

In conclusion, we see that the GDP of a country is significant and has a positive correlation to its spending on environmental protection across all models. This supports my hypothesis that countries with a higher GDP are likely to spend more towards environmental protection. Another outcome from this study is that countries that have a higher environmental performance index tend to spend more on the environment as a result. Carbon emissions do not show significance in the model, but it does show a high collinearity between GDP. In the general model, it has a negative relationship between environmental expenditures. Moreover, urbanization rate does not show any significance within the model.

Although the dummy variables were not significant in the models, we see that there is a positive correlation between high-income countries and the dependent variable, but a negative correlation with middle-income countries. Status as an OECD member contributed to a positive correlation in environmental spending despite the result not being at the significance level. Income levels of nations do not have a significant effect on the amount of environmental protection expenditures.

All in all, my study demonstrates that economic factors such as GDP as well as environmental performance influence how much spending goes towards environmental protection. Being able to expand these results to a wider range of countries will be more indicative of the relationship between GDP and environmental protection expenditures and produce better, more accurate results. It is necessary to keep in mind the effects of climate change and its long-term implications. Analyzing the effects of the economy's role in mitigating environmental degradation is an important start to reducing its impact.

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Appendix

Stata Scatterplot:

```
. twoway (scatter logenvexpend loggdp) (lfit logenvexpend loggdp)
```

Stata Summary Statistics:

```
. summ logenvexpend loggdp logcarbemiss epi OECD urban middle high

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
logenvexpend |         97    8.387054    1.089148   6.087905   11.01831
      loggdp |         97    10.91288    .9529642   8.278483   13.15522
logcarbemiss |         97    4.428249    .9220608    1.90309   7.013404
         epi |         97     52.9701    16.53716       25.1       82.5
        OECD |         97    .3402062    .4762396          0          1
-------------+---------------------------------------------------------
       urban |         97    64.75979    21.09344       13.2        100
      middle |         97    .5360825     .501287          0          1
        high |         97    .4020619    .4928614          0          1
```

Stata Regression Output:

Model 1

```
. regress logenvexpend loggdp

      Source |       SS           df       MS      Number of obs   =        97
-------------+----------------------------------   F(1, 95)        =    334.54
       Model |  88.6927777         1  88.6927777   Prob > F        =    0.0000
    Residual |  25.1865604        95  .265121688   R-squared       =    0.7788
-------------+----------------------------------   Adj R-squared   =    0.7765
       Total |  113.879338        96   1.1862431   Root MSE        =     .5149

------------------------------------------------------------------------------
logenvexpend |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      loggdp |    1.00863   .0551455    18.29   0.000     .8991523    1.118108
       _cons |  -2.620007   .6040634    -4.34   0.000    -3.819224   -1.420789
------------------------------------------------------------------------------
```

Model 2:

```
. regress logenvexpend loggdp logcarbemiss epi urban
```

Source	SS	df	MS		
				Number of obs =	97
				F(4, 92) =	119.60
Model	95.5115811	4	23.8778953	Prob > F =	0.0000
Residual	18.3677569	92	.199649532	R-squared =	0.8387
				Adj R-squared =	0.8317
Total	113.879338	96	1.1862431	Root MSE =	.44682

logenvexpend	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
loggdp	.9166163	.1686945	5.43	0.000	.5815744	1.251658
logcarbemiss	-.0720792	.1618954	-0.45	0.657	-.3936175	.2494592
epi	.017645	.0040584	4.35	0.000	.0095847	.0257054
urban	.0004497	.0028675	0.16	0.876	-.0052454	.0061449
_cons	-2.26047	1.094521	-2.07	0.042	-4.434282	-.0866578

Model 3:

```
. regress logenvexpend loggdp epi
```

Source	SS	df	MS		
				Number of obs =	97
				F(2, 94) =	243.71
Model	95.4679539	2	47.733977	Prob > F =	0.0000
Residual	18.4113841	94	.195865789	R-squared =	0.8383
				Adj R-squared =	0.8349
Total	113.879338	96	1.1862431	Root MSE =	.44257

logenvexpend	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
loggdp	.847109	.0547801	15.46	0.000	.7383419	.9558762
epi	.018566	.0031567	5.88	0.000	.0122983	.0248338
_cons	-1.840792	.5358426	-3.44	0.001	-2.90472	-.7768643

Model 4:

```
. regress logenvexpend loggdp epi OECD middle high

      Source |       SS       df       MS              Number of obs =      97
-------------+------------------------------           F(5, 91)      =   99.03
       Model |  96.2002318     5  19.2400464           Prob > F      =  0.0000
    Residual |  17.6791062    91  .194275892           R-squared     =  0.8448
-------------+------------------------------           Adj R-squared =  0.8362
       Total |  113.879338    96   1.1862431           Root MSE      =  .44077

------------------------------------------------------------------------------
 logenvexpend|      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      loggdp |    .835041   .0555304    15.04   0.000     .7247367    .9453453
         epi |   .0127709   .0044819     2.85   0.005     .0038682    .0216737
        OECD |   .2097926   .1480113     1.42   0.160    -.0842136    .5037989
      middle |  -.0757759   .2005325    -0.38   0.706    -.4741091    .3225573
        high |   .0141586    .199748     0.07   0.944    -.3826163    .4109335
       _cons |  -1.438571   .5917779    -2.43   0.017    -2.614065   -.2630764
------------------------------------------------------------------------------
```

Correlation Matrix:

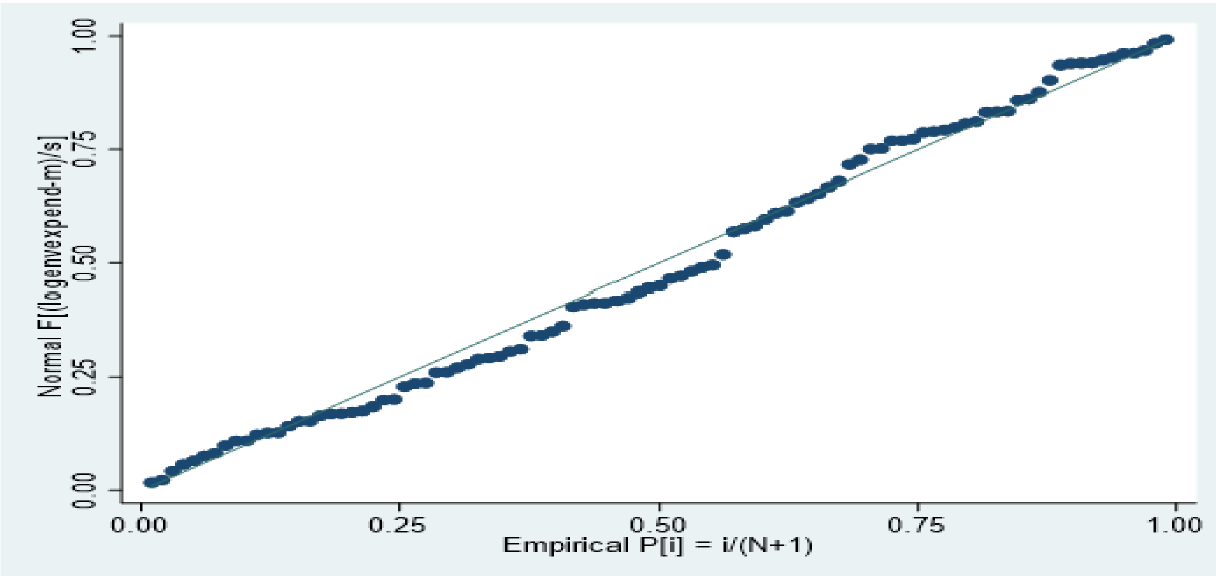
```
. corr logenvexpend loggdp logcarbemiss epi OECD urban middle high
(obs=97)

             | logenv~d   loggdp logcar~s      epi     OECD    urban   middle     high
-------------+------------------------------------------------------------------------
logenvexpend |   1.0000
      loggdp |   0.8825   1.0000
logcarbemiss |   0.7959   0.9435   1.0000
         epi |   0.6535   0.5013   0.3624   1.0000
        OECD |   0.5863   0.4503   0.2895   0.7092   1.0000
       urban |   0.5068   0.4328   0.3527   0.6441   0.4554   1.0000
      middle |  -0.4728  -0.3244  -0.1491  -0.6831  -0.6846  -0.4410   1.0000
        high |   0.4637   0.3194   0.1751   0.6873   0.6538   0.4958  -0.8815   1.0000

.
```

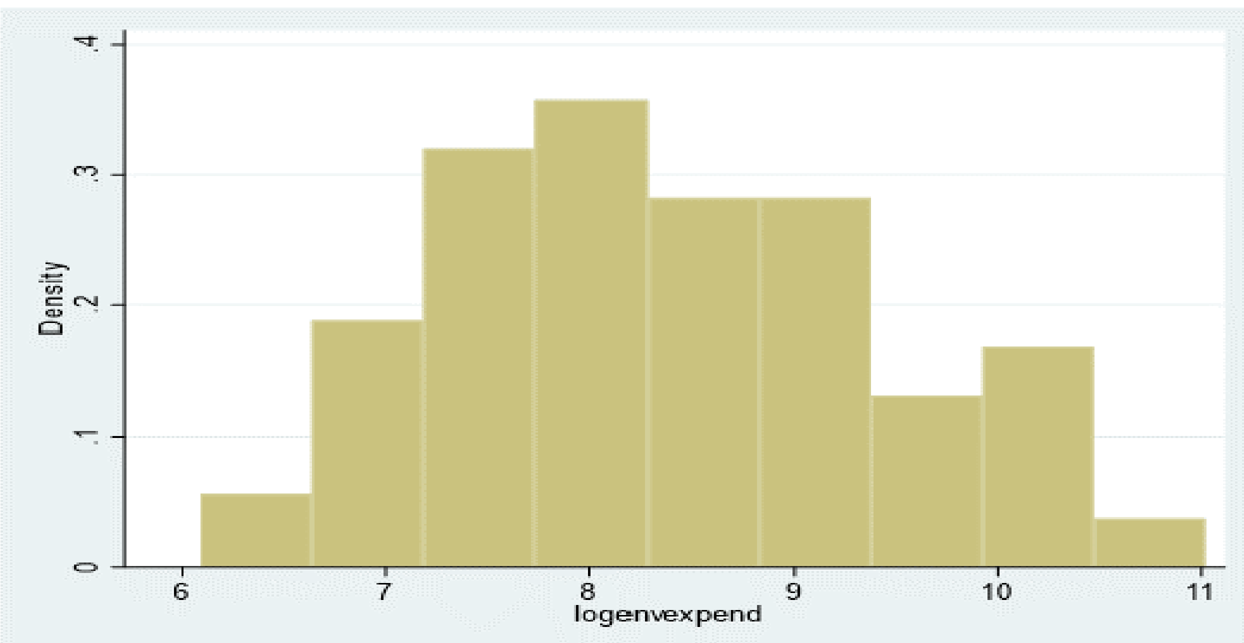
```
. pnorm logenvexpend
```

APPENDIX A: Normal Probability Plot of Dependent Variable



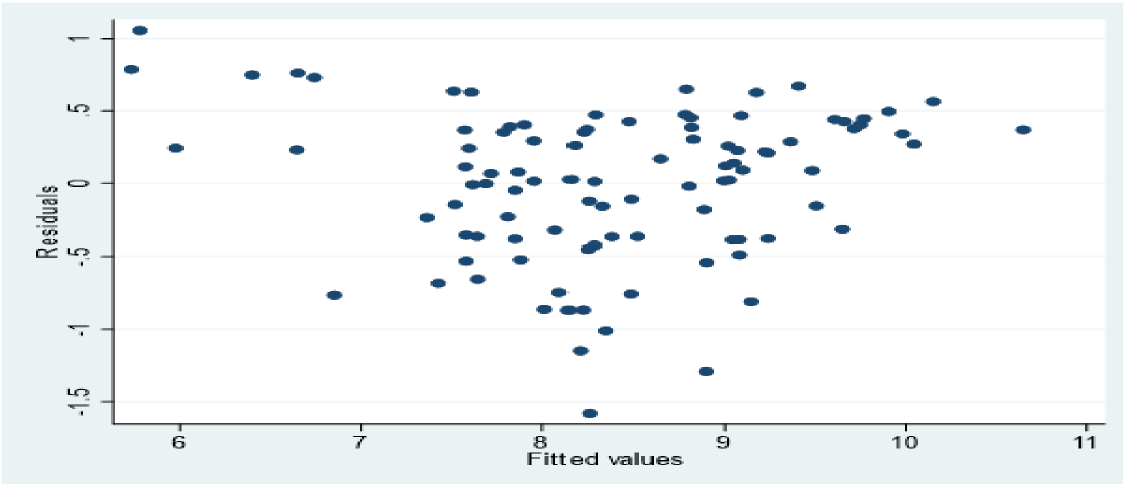

```
. histogram logenvexpend
(bin=9, start=6.0879054, width=.54782232)
```

APPENDIX B: Histogram of Dependent Variable




```
. rvfplot
```

APPENDIX C



List of Countries

Non-OECD Member Countries									
Afghanistan	Albania	Angola	Argentina	Armenia	Azerbaijan	Bahamas, The	Bahrain	Bangladesh	Belarus
Bhutan	Botswana	Brazil	Bulgaria	Burkina Faso	Cabo Verde	China	Cote d'Ivoire	Croatia	Cyprus
Egypt, Arab Rep.	El Salvador	Georgia	Germany	Guatemala	Indonesia	Jamaica	Jordan	Kazakhstan	Kenya
Kiribati	Kyrgyz Republic	Lebanon	Malaysia	Malta	Marshall Islands	Mauritius	Micronesia, Fed. Sts.	Moldova	Mongolia
Myanmar	Namibia	Nepal	Nicaragua	North Macedonia	Panama	Papua New Guinea	Philippines	Romania	Russian Federation
Samoa	Seychelles	Singapore	Solomon Islands	South Africa	Tanzania	Thailand	Trinidad and Tobago	Uganda	Ukraine
United Arab Emirates	Uruguay	Uzbekistan	Zambia						
OECD Member Countries									
Australia	Austria	Belgium	Canada	Chile	Costa Rica	Czech Republic	Denmark	Estonia	Finland
France	Greece	Hungary	Iceland	Ireland	Israel	Italy	Japan	Latvia	Lithuania
Luxembourg	Netherlands	New Zealand	Norway	Poland	Portugal	Slovak Republic	Slovenia	Spain	Sweden
Switzerland	Turkey	United Kingdom							